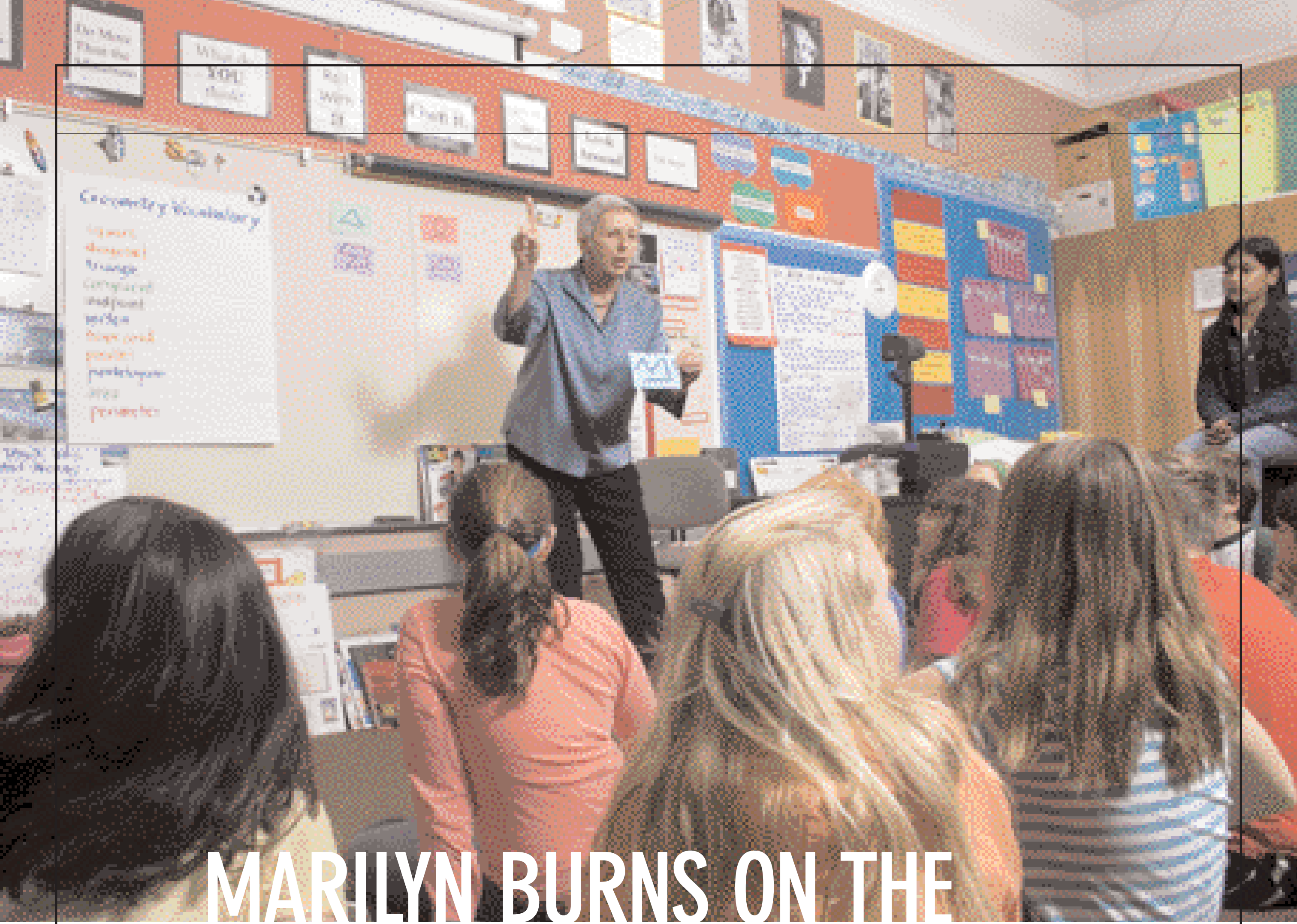


MARILYN BURNS ON THE LANGUAGE *of* MATH

Parlez-vous geometry? Sprechen sie fractions? An expert's guide to teaching math's unique vocabulary.

Math can sometimes seem like a strange language from a foreign land—one communicated in symbols, numbers, and geometric figures. And when we talk about mathematical concepts, even familiar, garden-variety words—such as *parallel*, *power*, *even*, *odd*, *multiply*, *difference*, *product*, *positive*, and *negative*—take on brand-new meanings.

What's the best way for teachers to help students master this unique vocabulary? In 2000, after analyzing two decades of research on vocabulary instruction, the National Reading Panel concluded that there is no one best method for teaching vocabulary. Rather, teachers need to use a variety of methods for the best results, including intentional, explicit instruction of specific vocabulary words.

With this in mind, we asked Marilyn Burns, founder of Math Solutions Professional Development and a frequent contributor to *Instructor*, how teachers can effectively integrate math vocabulary into their lesson plans.

Q How is math like another language?

A The meanings of words in general usage are often very different from their mathematical meanings. Take *even*, for example: In common usage we talk about shares being even when each person has the same amount, or knitting stitches being even when they are consistently the same size, or a person having an even disposition, or getting even when we feel we've been wronged. This is further complicated in the context of mathematics where we use *even* to describe a whole number divisible by 2, which means it can be divided (or shared, if you like) into two equal groups with nothing remaining, or a remainder of zero.

PHOTOS: BOB ADLER

Even is just one example. In common usage, *meter* can refer to a poetic rhythm or to a device, like a water meter, that measures flow; in mathematics, *meter* is a unit of length. In common usage, when we talk about things that *multiply*, such as animals or plants, we mean that they increase in number; when we *multiply* numbers in mathematics, however, we specifically mean that we are combining a certain number of equal size groups, which we often describe as repeated addition. And while the quantities always increase in real-world contexts when things multiply, in the world of mathematics, when we multiply fractions, the answer is often less than one or both of the numbers we multiply!

Q Should we teach math the way we teach a second language?

A It's not exactly analogous to learning a foreign language. When studying Spanish, I learned new words for naming things, asking questions, describing my thoughts, and so on. But I already had knowledge about the ideas I wanted to express, and learning Spanish was all about learning a new language for communicating these ideas.

In contrast, the purpose of the language of mathematics is communicating about mathematical ideas, and it's necessary first to acquire knowledge about the ideas that the mathematical language describes. Only when I understand mathematical ideas do I have a reason for learning the correct language of mathematics to communicate about these ideas.

Q What's the best way to teach both ideas and vocabulary?

A Mathematical vocabulary, and also mathematical symbols, are determined by social conventions. For example, it's not possible to figure out through reasoning that the numbers we multiply are called *factors*— this is an arbitrary, agreed-upon convention. In contrast, mathematical ideas have their foundation in logic. The source of the knowledge lies inside the learner.

For both types of knowledge—social and logical—explicit instruction is essential. However, the character of the instruction vastly differs. For teaching social knowledge, we must provide the information to the learner—through explanations or through access to another source of information. There's no way to figure out on our own that numbers that aren't divisible by 2 are called odd numbers, for example.

However, knowing if a specific number is or isn't divisible by 2 calls for mathematical knowledge that we gain by synthesizing what we know about division, and connecting this understanding with what we know about patterns of numbers. Teachers must first make sense of these concepts themselves, then use appropriate instruction that helps kids make their own sense of the concepts.

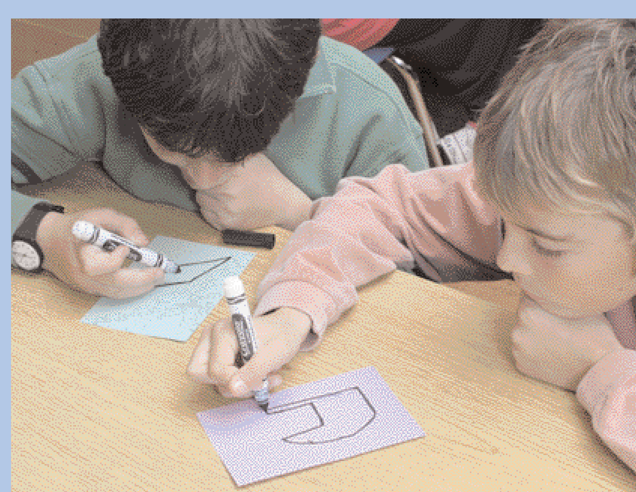
POLYGON POWER: FROM CONCEPTS TO VOCAB

Building on their prior knowledge of geometry, Marilyn Burns teaches Danielle Ross's fifth-grade class at Park School in Mill Valley, California, how to define and classify polygons.

STEP 1: I drew a vertical line to divide the board into two columns and placed two shapes drawn on cards in each column. I didn't label the columns yet, but planned later to label the left column "Polygons" and the right column "Not Polygons."

STEP 2: I held up four more shapes, and students voted as to which column they should go in. I then told them where each shape belonged and placed it there.

STEP 3: I asked students to think quietly about what they thought was my classification system. Then, in pairs, they talked about their ideas and drew a shape they would like to add to the chart.



Q Give us an example of teaching a math concept followed by the relevant vocabulary.

A To help young children develop understanding about even and odd numbers, I use an activity called Two-Hand Take Away.

First give each child seven objects, such as cubes, and have them place them in a row. Then, using both hands, the children take one away from each end of the row. Verify with them that now there are only five cubes in the row. Have them do this again, leaving three, and once more, leaving only one cube. Now they're done because it's not possible to do another two-hand take away. Now repeat the activity with eight objects; this time they wind up with no cubes left over.

Have children keep track of what happens by writing the numbers of cubes they start with in one of two columns: "Zero Left Over" or "One Left Over."

After they record the activity using seven and eight objects, they can try again using other numbers of their choice. Encourage students to predict each time.

After many trials, give each child a 1-to-100 chart titled "Zero Left Over."(List 1 through 10 across the top, 11 through 20 underneath it, 21 through 30 underneath that, and so on.) Ask kids to color in all the numbers with zero left over. Now talk about the pattern, both on the chart (colored-in numbers are all in the same columns) and by looking at the digits in the ones places (which are always 0, 2, 4, 6, or 8). After children can predict what will happen for any number of objects when they do Two-Hand Take Away, they're ready to learn the mathematical language: that those numbers with zero left over are *even* and those with one left over are *odd*.

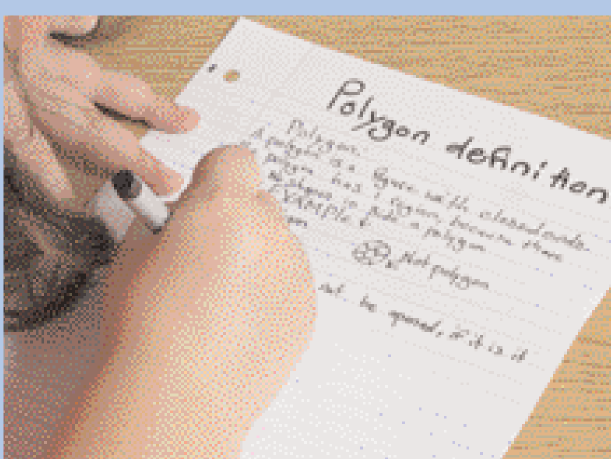
Q What other strategies are best for teaching math vocabulary?

A First, identify the vocabulary to be taught. It's important to determine the relevant terminology for each unit of study and for daily lessons. Introduce the vocabulary only after developing understanding of the related mathematical ideas, connecting its meaning to the students' learning experiences.

Write new vocabulary on a class chart. Seeing words written is supportive for all students, and essential for some. Have students keep their own lists. Copying words from the chart will give students a first experience with writing them down, and they can use these lists for at-home assignments.

When vocabulary relates to mathematical symbols, point to the symbols when saying the words. Have the students pronounce the words themselves.

Encourage students to use the vocabulary in discussions and on assignments, and use it repeatedly and consistently yourself. Prompt students to use new terminology when they present ideas or complete assignments. For older students, introduce words with multiple meanings, and have kids define them. □



STEP 4: Next, students shared their drawings, and we worked together to sort them correctly on the chart.

STEP 5: I labeled the columns: "Polygons" and "Not Polygons." I asked what they thought were the characteristics of the shapes that were polygons, and I wrote their ideas on the board. Together, we wrote a definition of *polygon.*

STEP 6: Finally, I used the shapes posted to introduce or reinforce additional vocabulary related to polygons: *triangle, quadrilateral, square, parallelogram, rhombus, rectangle, pentagon,* and so on.